LETTERS TO THE EDITOR.

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The Term "Radian" in Trigonometry.

FROM a recently published part of the "New English Dictionary" it is to be inferred that the first authority for the use of the word "*radian*" was the "Treatise on Natural Philosophy" of Thomson and Tait, the date given being 1879—that is to say, the date of the new edition of part i. of vol. i. As the word has at least ten years of previous history, it may be desirable to put on record a few additional facts in regard to it. My own first use of it was in class-teaching in the College Hall at St. Andrews in 1869, and I possess a note-book, belonging to one of my students of that year, in which the word is used. The introduction of it was almost simultaneous with my proposal of the word "therm" in connection with the measurement of heat.

The advantages of the latter word I went so far as to point out in a letter to NATURE dated almost exactly forty years ago (see vol. i., p. 606). At that time I was inclined to suggest the form "rad" in preference to "radial" or "radian," it being advantageous to have a monosyllable for the fundamental unit of a series if auxiliary units like "kilotherm," "millirad," &c., were likely to be called for (see NATURE, vol. iii., p. 426).

It was in 1874, after several conversations on this and similar subjects with the late Prof. James Thomson, of Glasgow, and especially after an exchange of letters with the late Alexander J. Ellis, that the form "radian" was definitely adopted by me. In that year I came across the following passage in an interesting historico-biographical note written by Ellis as an appendix to his "Algebra Identified with Geometry" (London, 1874):—"Let u be a unit-line, then, if r and ζ be both real numbers, $re^{\zeta i}u$ represents a line of the length ru and inclined to u at ζ radial angles" (p. 82), there being added in brackets the definition "2π radial angles=4 right angles." As a consequence I wrote to him, and he declared at once for the form "radian," on the ground that it could be viewed as a contraction for "*radi*-al *an*-gle" in accordance with precedents in chemistry which he had himself followed in his nomenclature of the so-called "stigmatic" geometry. He also incidentally mentioned that he had used the expression "radial angle" from his Cambridge undergraduate days.

THOS. MUIR.

Cape Town, South Africa, March 6.

The Fertilising Influence of Sunlight.

THE letters on the above subject in NATURE of February 17 and March 3 and 10 are of much interest. In many parts of the world artificial heating of the soil is a regular practice. For example, in the rice districts of heavy rainfall in the Bombay Presidency the seed-bed for transplanted rice and some small millets is almost invariably subjected to a process known in the vernacular as "rab." This consists of spreading a layer of branches, grass, cow-dung, &c., over the surface of the plot (often only a few metres square) selected as the site of the seed-bed. This material is then slowly burnt before the breaking of the monsoon.

There is a general agreement as to which kind of "rab" is best, that consisting largely of cow-dung (in the form of a plaster with chopped straw) being considered by far the best. Then comes that composed of the branches of certain species of Terminalia, after which come those of any available trees, and finally that composed of dried grass.

An experiment I conducted on these materials in the year 1906–7 at Lanowli, in the rice district above the Ghats between Bombay and Poona, gave the results stated below. Unfortunately, an untimely shower fell a few days before the material was burnt, so that the temperature of the soil was probably not raised so high as in ordinary seasons; this temperature was taken by scraping off the ashes at various points and inserting a thermometer 3 or 4 centimetres into the soil immediately after burning; it varied between 200° and 230° F.

The material was prepared and burnt in the ordinary method used by the natives; in addition, plots were added, one of which was manured with safflower (*Carthamia tinctoria*) cake, another with cow-dung, another with ashes scraped off a "rabed" plot, while in a fourth the soil was finely pulverised to a depth of about 8 cm., and in a fifth the surface soil was removed to this depth, placed on iron sheets, and heated from beneath until a temperature of 200° to 230° F. was reached, when it was allowed to cool.

At the time of transplanting, twenty average seedlings were taken from each of the plots, dried, and weighed.

The results were as follows:—

Treatment of plot	Average dry weight of seedlings (in grams) in each of the triplicate plots			Mean
	A	B	C	
1. Manured with safflower cake.	0·4097	0·4967	—	0·4532
2. "Rabed" with branches of Terminalia	0·0879	—	—	0·0879
3. "Rabed" with mixed branches	0·2181	0·1708	0·1430	0·1773
4. Manured with ashes of mixed branches	0·0797	0·1094	0·0954	0·0948
5. Manured with cow-dung	0·0928	0·0772	—	0·0850
6. "Rabed" with cow-dung	0·2561	0·3172	—	0·2866
7. Soil pulverised	0·0909	0·0625	0·1000	0·0845
8. Soil heated	0·3562	0·2968	0·2276	0·2935

It should be noted that owing to scarcity of this material at the time sufficient branches of Terminalia could not be obtained even for the single plot. Hence, probably, the poor result on this plot.

From the above it will be seen that the *raison d'être* of this process is to obtain the effect of heat, and neither to improve the physical condition of the soil (cf. plots 7 and 8) nor to supply plant food (see plots 4 and 5). The ashes have practically no value, and the natives state that it is of no consequence when the ashes, as is often the case, are removed by wind.

The enormous effect of safflower cake is well known, an application to sugar-cane being many times more efficient than that of any other cake when applied to give equal quantities of nitrogen. The reason for this is under investigation.

The fertilising effect of heat on soils has been known for ages, as witness the ancient practice above detailed. That, however, it is due to the causes assigned by Drs. Russell and Hutchinson, viz. a partial sterilisation of the soil, is very much open to doubt. In their extremely interesting work at Rothamsted they find an increase in bacterial activity and rate of increased decomposition of organic matter after partial sterilisation associated with an increased crop yield. There is the possibility, however, that these latter phenomena are accompaniments, and not the causes, of the increased crop-yields, all being the result of a destruction of toxic material in the soil. In any case, the theory put forward is apparently incapable of explaining many causes of sterility in soil, and is, apparently, not a general explanation that has any practical bearing on the general question of soil fertility. For example, it is difficult to see how it can account for the fact that certain plants will not grow in the immediate neighbourhood of others, as the present writer has found to be the case ("Memoirs of the Department of Agriculture in India," Bot. Ser., vol. xi., No. 3, April, 1908).

The excellent work of the U.S. Bureau of Soils has proved that roots of plants excrete a toxic substance. The present writer has noted the same phenomenon, and has further isolated the substance from water in which plants have been cultivated. A further paper on this question is in preparation. It may, however, be stated here that if water rendered toxic by the growth in it of plants is shaken with benzene, toluene, chloroform, or carbon bisulphide (the antiseptics used in experiments for partially sterilising soil), this toxic substance is rendered insoluble, and therefore innocuous.

As an example, when such water is shaken with toluene, an emulsion is formed which floats on the surface of the water. If this emulsion is poured off and the toluene and water allowed to evaporate, a residue is left

which is not soluble in water (or at least not in the quantity of water from which it was extracted).

It therefore appears probable that the effect of toluene on the soil is to render insoluble and innocuous this toxic substance. Similarly with the other antiseptics mentioned; ether apparently does not convert the substance into an insoluble form, and its method of acting is being investigated.

The writer has also found that heating to dryness on a water-bath decomposes this substance, and it is probable when in the soil that a lower temperature will suffice. It seems probable, therefore, that the fertilising effect of sunlight will be found to be due to the decomposition of this toxic substance.

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TRANSCASPIAN ARCHÆOLOGY.[1]

IN the two volumes referred to below are incorporated the results of the American expedition which visited Russian Turkestan under the direction of Mr. Raphael Pumpelly, the well-known geologist, in 1904, and, besides conducting excavations at Anau, near Askhabad, collected material bearing on the physiography of the Central Asian deserts and oases. Thus the work of the expedition was two-fold. On one hand, we are presented with geological and physiographical observations, illustrating changes which have taken place in the character of Central Asia; on the other, we have a full and able presentment of the archæological material obtained from the excavations at Anau, including a very complete ceramic record. We should add that the excavations were directed by Dr. Hubert Schmidt, of Berlin, who joined the staff of the expedition for that purpose.

On the physical side, Mr. Pumpelly, assisted by Messrs. Davis, Huntington, and R. W. Pumpelly, who were also members of the expedition, found traces in High Asia of several great glacial expansions during the Glacial period. According to the picture which he gives us, there existed a cap of continental ice, thousands of feet thick, which spread over nearly the whole of European Russia; and Central Asia was covered by a huge inland sea, larger than the Mediterranean, and fed by rivers flowing from the snow and ice. The sub-Glacial period was marked by a general trend towards desolation, accompanied by the disappearance of the ice-cap from Russia and a diminution of the great glaciers on the southern mountains. As evaporation became more rapid than the inflow of water, the inland sea shrunk and broke up into smaller basins, and the dried silts of seas and rivers were carried by the wind in great columns of dust across the earth. The lightest material was carried farthest, and deposited in beds of loess, the extraordinarily fine and fertile soil which covers a great part of the surface of Northern China and Turkestan, and extends in a continuous zone from north of the Caspian to Austria. The heavier silts, in the form of sands, moved more slowly along the surface of the plains, where they formed great seas of sand-dunes, heaped up in places to a height of more than a hundred feet. We may note that to the shifting of such sand-deserts in historic times we owe the burial of cities in the Khotan region, which have been so successfully excavated by Dr. Stein for the Indian Government. With regard to the geological side of his work, we certainly think that Mr. Pumpelly's researches on the spot tend to confirm Richthofen's theory of the wind-borne origin of loess, and he has succeeded in obtaining further evidence of his own modification of the theory as to the important part played by river silts, and the chemical action of vegetation, in furnishing the constituents of loess.

As a deduction from his archæological researches, Mr. Pumpelly would regard the Central Asian oases as the fountain-head of Western Asiatic culture. According to his theory, their inhabitants were isolated from Africa and Europe from the Glacial period onward, and their cultural requirements were consequently evolved in complete independence. Changes in climatic conditions, however, took place, under which the early civilisations in these regions tended to disappear, and these gave rise to extensive migrations, which eventually reacted on the outside world. In support of his theory, Mr. Pumpelly would trace the early appearance of wheat and barley in Babylonia and Egypt, and the presence of certain breeds of domestic animals, to their first establishment in the Transcaspian oases. Moreover, he would place the original home of the Sumerians in Central Asia, where, before their arrival in Babylonia and their subsequent fusion with Semitic nomads, he pictures them as having already acquired the elements of their racial culture and organisation under the stern discipline of a struggle with nature. The absence of any form of writing in the mounds of Anau may be cited as negative evidence against any racial, or even cultural, connection with the Sumerians, though, as we shall see later, a study of the ceramic points to some influence having been exerted from that quarter on the early cultures of Susa in Elam.

In this connection it is indeed a moot point whether the parent civilisation was not that of Elam herself.

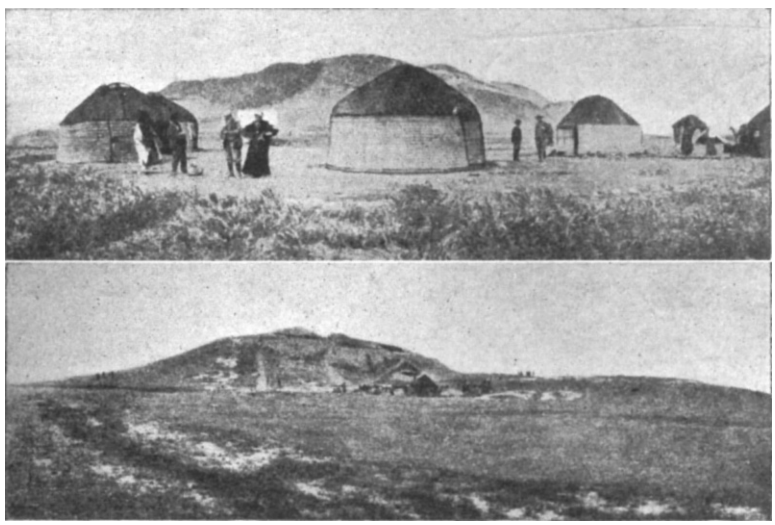

FIG. 1.—(1) The North Kurgan at Anau, in Russian Turkestan, with the Camp of the Pumpelly Expedition in the foreground. (2) The South Kurgan at Anau, showing excavations in progress.

[1] Explorations in Turkestan: Expedition of 1904. Prehistoric Civilisations of Anau. Origins, Growth, and Influence of Environment. Edited by Raphael Pumpelly. Vol. i., pp. xxxvi+240+vi; vol. ii., pp. x+(241-494)+x; with 97 plates and 548 illustrations, including maps and plans. (Washington: Carnegie Institution, 1908.)